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WATER RESOURCES STUDY - MARMATON RIVER BASIN, KANSAS AND MISSOURI. STUDY OF POTENTIAL NEEDS AND VALUE OF WATER STORAGE FOR MUNICIPAL, INDUSTRIAL, AND QUALITY CONTROL PURPOSES

Public Health Service
Kansas City, Missouri

March 1964

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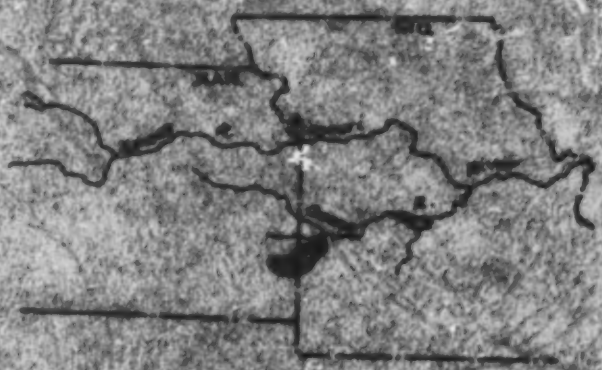
WATER RESOURCES STUDY MARMATON RIVER BASIN KANSAS AND MISSOURI

Study of Potential Needs and Value of Water Storage for Municipal, Industrial, and Quality Control Purposes



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WATER RESOURCES STUDY
MARMATON RIVER BASIN
KANSAS AND MISSOURI

Study of Potential Needs and Value of Water Storage for Municipal, Industrial, and Quality Control Purposes

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VI
Kansas City, Missouri

DEPARTMENT OF THE ARMY
U. S. Army Engineer District - Kansas City, Missouri

MARCH 1964

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I. INTRODUCTION

Authority

In a letter dated October 29, 1963, the Kansas City District of the Corps of Engineers requested the Public Health Service to make an investigation of the present and prospective needs for municipal and industrial water supply and for the regulation of streamflow for water quality control in the Marmaton River Basin.

This study has been made in accordance with the Memorandum of Agreement dated November 4, 1958, between the Department of the Army and the Department of Health, Education and Welfare, relative to the Water Supply Act of 1958 (Title III of Public Law 85-500) and the Federal Water Pollution Control Act of 1956, both as amended by Public Law 87-88.

Purpose and Scope

The purpose of this study is to determine the need for and value of storage for municipal and industrial water supply and streamflow regulation for quality control in the Marmaton River, a tributary of the Osage River. The study area is the Marmaton River Watershed.

The study covers water storage needs for municipal and industrial water and for streamflow regulation for quality control during the study period of 1960 to 2060.

Acknowledgments

The cooperation of the following Federal, State, and local agencies which were contacted for information and assistance is gratefully acknowledged:

1. City officials of Fort Scott, Kansas
2. City officials of Nevada, Missouri
3. Kansas State Department of Health, Topeka, Kansas
4. Kansas State Geological Survey, Department of Oil and Gas, Lawrence, Kansas.
5. Kansas Water Resources Board, Topeka, Kansas
6. Missouri Division of Health, Jefferson City, Missouri
7. Missouri Industrial Development Commission, Jefferson City, Missouri
8. Missouri Water Pollution Board, Jefferson City, Missouri
9. Missouri Water Resources Board, Jefferson City, Missouri
10. State of Missouri, Division of Geological Survey and Water Resources, Rolla, Missouri
11. U. S. Army Engineer District, Kansas City, Corps of Engineers
12. U. S. Bureau of Mines, Bartlesville, Oklahoma
13. U. S. Geological Survey, Ground Water Branch, Lawrence, Kansas
14. U. S. Geological Survey, Surface Water Branch, Topeka, Kansas, and Rolla, Missouri
15. U. S. Geological Survey, Water Quality Branch, Topeka, Kansas

II. SUMMARY AND CONCLUSIONS

Summary

1. The Fort Scott Dam and Reservoir is proposed for construction on the Marmaton River, a tributary of the Osage River, about eight miles west of Fort Scott, Kansas.

2. The study area is the Marmaton River drainage basin, located in parts of Allen, Bourbon, and Crawford Counties in Kansas, and Barton and Vernon Counties in Missouri. For statistical interpretation, economic projections were made for the entire Counties of Vernon, Missouri and Bourbon, Kansas.

3. The area of the Marmaton River drainage basin is approximately 1200 square miles.

4. Population of the two-county study area was 36,630 in 1960, of which 17,826 was urban and 18,804 was rural.

5. Fort Scott, Kansas, and Nevada, Missouri, are the two principal communities having 1960 populations of 9,410 and 8,416, respectively.

6. Average daily 1963 municipal and industrial water use in the area amounts to 2.6 mgd (million gallons per day) to supply a population of 24,000 people, or an average per capita use of approximately 108 gpcd (gallons per capita per day).

7. The raw wastes produced at Fort Scott, Kansas, are approximately 13,300 P.E. (population equivalents) and 10,500 P.E. at Nevada, Missouri.

Conclusions

1. The urban population of the two-county area will grow from 17,826 persons in 1960 to 50,000 persons by 2010 and to 105,000 persons by

the year 2060.

2. Municipal and industrial water demands for the two major municipalities in the study area, Fort Scott and Nevada, will increase from 2.0 mgd in 1960 to 18.0 mgd by the year 2060.

3. Water storage in Fort Scott Reservoir will provide for future municipal and industrial water needs for Fort Scott, Kansas, and Nevada, Missouri, with an estimated population of 80,000 in 2060.

4. The value of storage in Fort Scott Reservoir to meet the municipal and industrial water demands, which natural runoff does not supply, is $18,700 per year for the duration of the study period.

5. Total streamflows needed for quality control at the two main pollution points, Fort Scott and Nevada, are shown in Table No. VIII-2. Streamflow regulation required for quality control is as shown below:

Year	Draft on Storage Above Reservoir Inflow Required For Water Quality Control Acre-feet/year
1960	1,800
2010	4,600
2060	11,200

6. The value of storage to supply the above streamflow regulation for quality control is $75,900 per year for the duration of the 100-year study period.

7. Maintenance of satisfactory water quality in the Marmaton River will benefit a wide spectrum of water uses in the study area. Recreational opportunities, including fishing, swimming, water skiing,

and boating will be increased. The esthetic values of the stream stemming from clean surface waters and a satisfactory public health water environment will be restored and the restoration or preservation of property values in areas contiguous to the stream will thereby be assured. Practically all communities now have adequate waste treatment plants either in operation or under construction.

III. DESCRIPTION OF PROJECT

Location

The Fort Scott Reservoir site is located in Bourbon County on the Marmaton River in southeastern Kansas, about eight miles west of the City of Fort Scott. The reservoir watershed covers parts of Bourbon, Crawford and Allen Counties. See Figure No. 1 in Section IX.

Streamflow

The Fort Scott gaging station is located on the Marmaton River at Fort Scott, Kansas, about 2½ miles west of the State line. During the 35 years of record (1921-24, 1929-61) periods of no flow were reported at times in 1934, 1936, 1939, and 1942-1945. The maximum discharge was 38,100 cfs and the average discharge during the 35 years of record was 299 cfs. 10/

Water Quality

Data available from "Chemical Quality of Surface Waters in Kansas, 1957-1960", compiled and published by the Kansas State Department of Health indicate the following mineral concentrations of the Marmaton River. The samples were collected at the Fort Scott municipal water plant intake during the period of October 29, 1956 to March 29, 1960. 11/

Marmaton River Chemical Analyses

(Fort Scott Municipal Water Plant Intake)

Concentrations in Milligrams per Liter (mg/l)

Constituent	Maximum	Minimum
Dissolved Solids	331	113
Hardness ($CaCO_3$)	288	72
Chlorides (Cl)	13	4
Sulfates (SO_4)	47	7
Nitrates (NO_3)	8.0	0.4

The chemical concentrations are below the 1962 Public Health Service Drinking Water Standards (limits not to be exceeded). The maximum nitrate concentration is high for surface waters and may contribute to algal growths in the reservoir.

Pertinent Data

As proposed, the Fort Scott reservoir will control natural runoff from a drainage area of 280 square miles. Storage space data for the proposed reservoir at 100-year conditions are shown below in acre-feet: 12/

Flood Control	- 134,000
Conservation	- 74,000
Sediment	- 9,000
TOTAL	217,000

IV. DESCRIPTION OF STUDY AREA

Location and Boundaries

The study area as requested by the Corps of Engineers is the Marmaton River drainage basin located in parts of Allen, Bourbon, and Crawford Counties in Kansas, and Barton and Vernon Counties in Missouri. It is approximately 1200 square miles and the area is about evenly divided between Kansas and Missouri.

Geography and Topography

The Marmaton River Basin is part of the Osage River Basin as shown on Figure No. 1. Lands in the Marmaton River Basin rise from an elevation of 720 feet at the mouth, to a maximum elevation of 1,100 feet. The topography is generally rolling with well-defined stream channels.

Climate

Climate of the Marmaton River Basin is characterized by hot summers and moderately cold winters. The mean annual temperature in the basin is about 56° F with extremes of approximately 118° F and -35° F being recorded. Temperatures suitable for growing crops prevail for about 180 days during the spring, summer and fall.

V. ECONOMICS

Present

The study area, for statistical interpretation in this section of the report, was defined as the entire counties of Vernon, Missouri and Bourbon, Kansas.

The economy of the two-county study area is based on the services (including construction, transportation, communication, utilities, retail and wholesale trade, public administration, government, and personal services), agriculture, and manufacturing in that order of importance. In 1960, the services contained 8,249 persons or 64 percent of the total labor force (12,962), while agriculture and manufacturing contained 2,831 and 1,321 persons respectively. Table No. V-1 depicts employment data for the two-county study area. 1/

Table No. V-1

The Number and Percent of the Labor Force by Major Subdivisions 1/

Marmaton River Study Area

	1950		1960	
	Number	Percent of Labor Force	Number	Percent of Labor Force
Farm	5,335	34	2,831	23
Mining	90	-	63	-
Manufacturing	1,053	7	1,321	10
TOTAL BASIC	6,478	41	4,215	33
TOTAL SERVICE	8,894	57	8,249	64
UNEMPLOYED	333	2	498	3
TOTAL LABOR FORCE	15,705	100	12,962	100
Population	41,838		36,630	
Ratio of Population to Labor Force	.375		.353	

Agricultural employment decreased almost 50 percent from 1950 to 1960. During the period 1949 to 1959, the number of farms decreased from 4,700 to 3,427, while the acres of cropland harvested have decreased from about 366000 to 330000. However, th value of all farm products sold increased from about $13.5 million in 1949 to about $18.3 million in 1959 (adjusted to the 1959 value of the dollar). Farm consolidation, intensive crop production, improved farming methods and a slight switch from crop to livestock production were primarily responsible for the increasing farm income and decreasing farm employment. Table No. V-2 depicts agricultural data for the Marmation River study area. [1,2]

Table No. V-2

Agricultural Trends

Marmaton River Study Area [2]

	Number Farms	Cropland Harvested (Acres)	Value of all Farm Products Sold*
1949	4,700	365,823	$13,507,281
1954	4,202	350,541	12,059,928
1959	3,427	329,670	18,341,797

*Adjusted to the 1959 value of the dollar.

The importance of manufacturing to the economy of the two-county study area has been increasing. When measured in terms of employment, there has been a 20 percent increase from 1,053 in 1950 to 1,321 in 1960. The most significant increases were in the textile and apparel, and fabricating metals categories.[1] Table No. V-3 depicts employment data in the manufacturing category.

Table No. V-3

Manufacturing Employment [1/]

Marmaton River Study Area
1950 - 1960

	1950	1960	Percent of Increase or Decrease
Manufacturing	1,053	1,321	26.0
Fabricating Metals Products	(247)	(360)	(46.0)
Food & Kindred Products	(244)	(228)	(-7.0)
Textile and Apparel	(250)	(484)	(94.0)
Printing and Publishing	(154)	(130)	(-16.0)
Other Manufacturing	(158)	(119)	(-25.0)

Value added by manufacturers, which is generally considered to be the best value measure available for comparing the relative economic importance of manufacturing among other industries has shown an increase since 1947. The number of establishments had a slight decrease since 1954, indicating less establishments with increasing employment and increasing value of products produced. Table No. V-4 depicts manufacturing trends for the Marmaton River study area. [3/]

Table No. V-4

Manufacturing Trends [3/]

Marmaton River Study Area
1947 - 1958

	Number of Establishments	Value Added by Manufacturers ($1,000)*
1947	**	4,900
1954	50	4,943
1958	46	8,339

*Adjusted to the 1959 value of the dollar.
**Data unavailable.

The commercial minerals available for extraction in the study area are stone, cement, petroleum, and coal. Employment in the mining category has decreased slightly and comprises less than one percent of the total labor force. 1/

The dollar values received from minerals extracted have been decreasing since 1953. The depletion of petroleum in the study area has been the main contributor to this decrease. Table No. V-5 depicts the annual value of minerals extracted from 1952 through 1960. 4/

Table No. V-5

Value of Minerals Extraction* 4/

Marmaton River Study Area
1952 - 1960
(Million Dollars)

	1952	1953	1954	1955	1956	1957	1958	1959	1960
Study area	1.2	3.0	1.1	**	1.5	1.2	1.3	1.2	.9

*Adjusted to the 1959 value of the dollar.
**Data unavailable.

The population of the study area has decreased over 30 percent since 1910. During this period, the urban segment remained relatively stable, while the rural segment has decreased almost 50 percent. This rural decrease is due primarily to the out-migration of the farm labor force to other surrounding areas (Kansas City, Tulsa, and Springfield) where there are increased industrial opportunities. Table No. V-6 depicts population data for the study area. 5/

Table No. V-6

Population Data for the 1/
Marmaton River Study Area
1910 - 1960

	1910	1920	1930	1940	1950	1960
Urban	17,639	17,832	18,211	18,738	18,344	17,826
Rural	35,195	31,435	29,206	27,792	23,494	18,804
TOTAL	52,834	49,267	47,417	46,530	41,838	36,630

Future

The economy of the area has been undergoing a change from a primary agricultural economy to a more balanced industrial-agricultural nature. This pattern of economic activity is expected to continue. Table No. V-7 depicts projected employment data by major categories for the study area.

Agriculture is expected to continue to make up a large portion of the future income of the study area. However, a continued increase in farm technology will achieve this high rate of production with a decreasing farm employment.

Manufacturing in the study area is expected to increase in employment and income. Employment in the manufacturing category is expected to increase to about 4,500 in 2010 and about 9,500 in 2060. The most significant increases are expected in the fabricating metals, food and kindred products and textile and apparel categories.

The mining category is expected to remain relatively stable with employment to increase slightly from 100 in 2010 to 200 in 2060. Dollar

values are expected to have modest increases primarily in the extraction of natural cement and stone. The extraction of petroleum and coal is expected to decrease in relative importance.

Communications, transportation, utilities, retail and wholesale trade and other personal services will continue to employ the largest portion of the labor force. An increasing proportion of the labor force will be employed in the dependent industries (services), with a lesser proportion employed in the basic categories (agriculture, mining, and manufacturing).

The change from a predominately agricultural type economy to a more diversified agriculture-manufacturing type is expected to reverse the downward population trend. This change is expected to increase employment in the manufacturing and service categories and this increase is expected to support a larger population throughout the study area. The expanding labor force is expected to increase the population to 64,000 by 2010 and 115,000 by 2060. These population projections are based primarily on projections made for the State and local areas. 6,7,8,9/ Table No. V-7 shows population and labor force projections for the study area for 2010 and 2060.

Table No. V-7

Projected Population and Employment of Labor Force 6,7,8,9/

Marmaton River Study Area
2010 - 2060

	2010		2060	
	Number (Thousands)	Percent of Labor Force	Number (Thousands)	Percent of Labor Force
Farm	2.4	11	2.0	5
Mining	.1	-	.2	-
Manufacturing	4.3	20	9.4	24
TOTAL BASIC	6.8	31	11.6	29
TOTAL SERVICE	14.5	66	27.2	68
UNEMPLOYED	.7	3	1.2	3
TOTAL LABOR FORCE	22.0	100	40.0	100
Population	64.0		115.0	
Ratio of Population to Labor Force	.345		.345	

VI. WATER RESOURCES

Surface Water

The Marmaton River Basin covers approximately 1200 square miles. The drainage area at Fort Scott is about 410 square miles and 280 square miles above the proposed damsite. The basin is subject to floods, occasioned by runoff from intense storms. The most frequent flooding usually occurs in April, May and June. During 36 years of record, there have been seven years with periods of no flow in the Marmaton River at Fort Scott, Kansas. Historical streamflows shown in Table No. VI-1 include the maximum, minimum, and average flows for the Marmaton, Little Osage, and Marais des Cygnes of the Osage River Basin.

Table No. VI-1

Historical Streamflows in the Osage River Basin* 10/

Marmaton River Basin

Station	Location	River Mile*	Years of Record	Flow in cfs Max.	Min.	Avg.
Marais des Cygnes R. near Ottawa, Ks.	0.9 mi. downstream from Main St. Bridge in Ottawa, Kansas	O-399	46	142,000	0	633
Marmaton R. at Ft. Scott, Ks.	1 mi. north of Fort Scott	M-33.5	36	38,100	0	301
Little Osage R. at Fulton, Ks.	3/4 mi. north of Fulton	L.O.-42	13	20,700	0	207
Marais des Cygnes R. near Kansas-Missouri State line	6.8 mi. upstream from Kansas-Mo. State line	O-313.5	5	148,000	3.4	-

*River miles are approximate

No long term surface water quality data are available. A comparison of other basins in this region and the short term quality data available on the Marmaton River show a remarkably low chloride content (maximum of 18 mg/l) for a stream having numerous oil fields in its drainage pattern. It was concluded that the mineral quality of the surface water in the Marmaton River Basin was satisfactory for use as municipal and industrial sources of supply.

Ground Water

In the upper portion of the study area, there are no large suitable ground water aquifers. The alluvial deposits in the valleys are thin and store only limited amounts of water.

In the lower portion of the study area, the quantity of available ground water is sufficient for small municipal supplies, but the mineral content of this water exceeds upper limits of the Public Health Service Drinking Water Standards. Exhibit No. 2 shows that several cities are now using this ground water for lack of a better source of supply. The typical analysis of the Nevada, Missouri, water supply is an example of this type of water. The total solids are 1529 mg/l and the chloride concentrations are 610 mg/l, considerably in excess of the limits of the 1962 Public Health Service Drinking Water Standards.

VII. MUNICIPAL AND INDUSTRIAL WATER SUPPLY NEEDS

Present

The principal water uses in the study area are municipal supplies and stock watering. Industrial water use in the area is small and recreational water use centers around several county-owned lakes.

Exhibit No. 1 shows that the present municipal water uses amount to 2.6 mgd (million gallons per day) to supply 24,000 persons for a basinwide average of 108 gpcd (gallons per capita per day). The Table of Typical Chemical Analyses, Exhibit No. 2, shows that several of the municipal supplies have mineral concentrations that exceed the 1962 Public Health Service Drinking Water Standards.

Fort Scott, Kansas, uses water from the Marmaton River when an adequate supply is available, and from a recently constructed two billion gallon impoundment, which serves as an auxiliary source of water. Water in the impoundment (Lake Fort Scott) is reported to be hard and the Fort Scott Water Department prefers to use the better quality water from Marmaton River when it is available.

Nevada, Missouri, has a well supply that is high in total dissolved solids (1,529 mg/l), chlorides (610 mg/l), and hardness (364 mg/l). See Exhibit No. 2 for "Typical Chemical Analyses" of the municipal water supplies in the study area.

The total dissolved solids and chloride concentrations for Nevada are in excess of the limits of the Public Health Service Drinking Water Standards of 1962. The high hardness concentration is undesirable for both domestic and industrial uses.

Prospective

It appears that the municipalities that could feasibly obtain municipal and industrial water from the proposed impoundment will be limited to the communities of Fort Scott, Kansas, and Nevada, Missouri, located on the main stem of the Marmaton River, downstream from the reservoir. Municipal and industrial requirements have been based on the projected needs of these two municipalities.

There are no major water using industries present or projected in the Fort Scott-Nevada locality. In 1960, the total municipal demands in these two municipalities amounted to approximately 108 gallons per capita per day. It is estimated that the total municipal use will increase to 175 gpcd by the year 2010 and to 225 gpcd by the year 2060.

Table No. VII-1 shows a sample of mean reservoir releases needed for municipal and industrial water supply. The releases contain 20 percent overage to cover such items as conveyance losses and atypical flow or demand conditions. This is not an operating scheme.

Table No. VII-1

Marmaton River Basin

A Sample Distribution of Mean Reservoir Releases Needed for Municipal and Industrial Water Supply in Acre-Feet

Month	Year		
	1960	2010	2060
January, February, March, April, May, June	0	268	3,170
July, August, September, October, November, December	394	2,810	7,050

The above releases are based on 0.02 probability of flows being equal to or less than volumes indicated, i.e., 98 percent protection level. Based on this protection level, a draft on storage of approximately 5,500 acre-feet per year will be needed by 2060.

Value of Storage

Most of the year Fort Scott, Kansas, can obtain ample water supply for municipal and industrial use from the Marmaton River, and can use the newly constructed Lake Fort Scott during extreme low flow periods. Nevada, Missouri, could presently obtain its municipal and industrial water supply from the Marmaton River and retain its well system for use during low streamflow periods.

Within approximately 50 years (2010) additional water for municipal

and industrial water supply will be needed for both Fort Scott and Nevada. The most feasible alternative for a municipal and industrial water supply for Fort Scott and Nevada would be a single purpose reservoir at the site chosen by the Corps of Engineers for the multipurpose reservoir. A single purpose reservoir of 9,200 acre-feet storage, plus approximately 4,000 acre-feet for sedimentation will be required. Using Senate Select Committee Print No. 32, the total 13,200 acre-feet reservoir storage would cost approximately $2,000,000.

An amortization period of 100 years and an interest rate of 4 percent was used for converting capital costs to equal annual costs. These costs were then discounted at 3 percent from year of first use (2010) to 1960. The annual value for storage for municipal and industrial water supply is $18,700.

VIII. STREAMFLOW REGULATION FOR QUALITY CONTROL

Present

The sewage treatment plants in the study area receive loadings of approximately 24,000 P.E. (population equivalents) per day. These treatment plants receive the wastes of about 50 percent of the entire basin population. Total plant efficiencies in the study area are better than 85 percent BOD removal. Sewage flows are estimated to be 70 percent of municipal withdrawals.

Low concentrations of chlorides (12 mg/l) and sulfates (30 mg/l) in the Marmaton River indicate that there is little or no inorganic pollution in the basin. There are no industries in the basin discharging large amounts of wastes to the stream without treatment.

11/20/63

Prospective

Future waste loadings to the Marmaton River below the proposed Fort Scott Reservoir have been estimated on the basis of population growth projections and on the projected increase in municipal water demands. The table below presents the main factors used in estimating the future pollution loads in the study area.

Table No. VIII-1

Waste Loading Projection Factors

Marmaton River Basin

	1960	2010	2060
Municipal Water Demand (gpcd)	110	175	225
Municipal Return (percent)	70	70	70
Organic Load (lbs.) per Population Equivalent (ultimate first stage BOD)	0.25	0.25	0.25
BOD Removal Efficiency (percent)	85	85	85

The pollutional effect of waste discharges on a receiving stream is a function of a number of variables. The main assumptions used in evaluating the need for quality control storage or regulation in the Fort Scott Reservoir service area are enumerated below:

1. Waste discharged to the streams of the basin will continue to be primarily organic in nature and specific mineral and/or organic toxicants will not be a significant problem.

2. Considering the needs for water and the cost of providing this water, it was decided that a degree of protection of 90 percent, represented by a 10 percent probability of flows being equal to or less than those provided for, would be reasonable for this area.

3. Maintenance of a level of 5 mg/l dissolved oxygen in receiving waters will provide adequate protection of aquatic life. This is in accordance with the objectives of the Missouri Basin Engineering Health Council.

4. Quality control needs were based on three different periods. The summer period will be five months long and have an average water temperature of 24° C. The winter period will be four months long and have an average water temperature of 2° C. The spring and fall periods will be three months long and have an average water temperature of 12° C.

The oxygen-sag method was used to determine the quality requirements at the two main pollution sources, Fort Scott and Nevada. The table below gives the flow required in the stream to meet the above quality requirement.

Table No. VIII-2

Minimum Streamflows for Quality Control
(Flow in mgd)

Marmaton River Basin

	Summer	Spring & Fall	Winter
1960			
Fort Scott	7	3	1
Nevada	12	4	2
2010			
Fort Scott	15	5	3
Nevada	24	9	3
2060			
Fort Scott	25	10	6
Nevada	43	18	6

The above table is not releases required. Part or all, in some cases, of these requirements are met by natural runoff. Exhibit No. 4 shows a sample distribution of mean reservoir releases, but is not an operating scheme.

Considering quality control needs, natural runoff, and municipal returns, Table No. VIII-3 lists the annual draft on storage above reservoir inflow needed from the proposed Fort Scott Reservoir to maintain a suitable quality objective in the Marmaton River.*

Table No. VIII-3

Summary of Net Regulation Requirements in Acre-Feet Per Year

Marmaton River Basin

Protection Level (%)	Year of Development 1960	2010	2060
90	1,800	4,600	11,200
70	290	1,200	3,900
50	50	900	2,400

* Figure No. VIII-1 shows this trend graphically

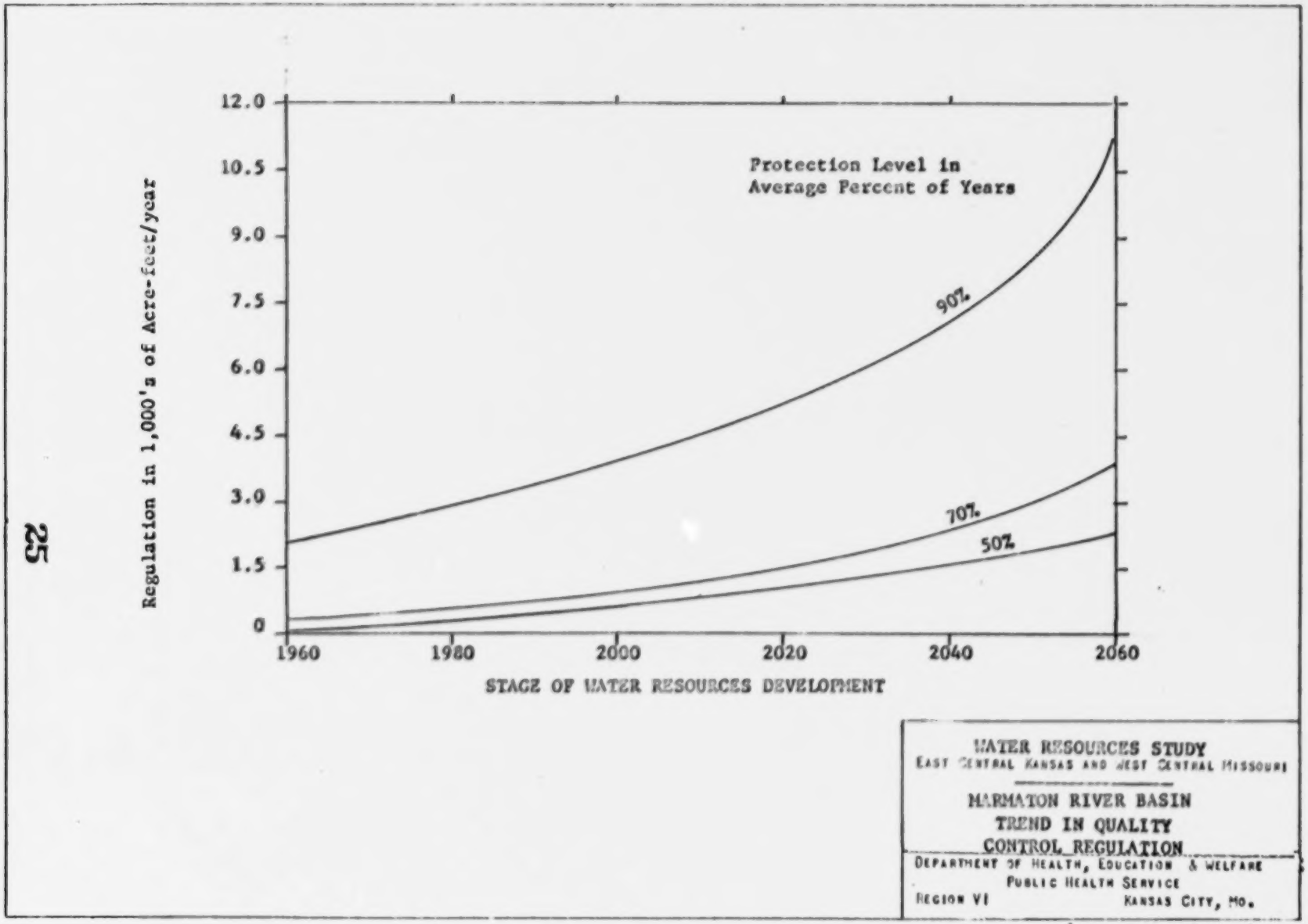


Figure VIII-1

Based on the 90 percent protection level, there is a need for a regulation of 11,200 acre-feet per year by 2060.

Benefits

Benefits attributable to storage for streamflow regulation for water quality control may be tangible, i.e., may have a measurable dollar value; or may be intangible with no measurable dollar value. Representing the former, water quality control management by the proposed Fort Scott Reservoir will provide recreational opportunities in the Marmaton River for a distance of approximately 55 river miles from the dam to the river's confluence with the Osage River just above Schell City, Missouri. Assured water quality will provide favorable conditions for recreation such as swimming, water skiing, boating, and fishing for those living in Fort Scott, Kansas, Nevada, Missouri, and intervening areas. Urban population of this area is estimated to be in the order of 115,000 by 2060. It is not unreasonable to anticipate that a total population in the study area in the order of 125,000 will be within an easy drive of the river and will be able to enjoy the opportunities it will offer.

In addition to recreational benefits, and falling into the intangible benefit category, riparian property owners will enjoy improved esthetics of the stream stemming from unpolluted surface waters and a satisfactory public health environment. Availability of water of more uniform quality, as well as quantity, is a strong attraction to water-

using industries, hence, industrial growth will be favored. It is entirely possible that impoundment will have a beneficial effect on the mineral solids content of the waters of the Marmaton, which could lower treatment costs. Increased flow of improved quality water will be discharged to the Osage River to the benefit of water quality in that stream. From the above, it is concluded that benefits are widespread in scope, and sufficient in magnitude to justify and warrant the provision of the indicated volume of storage for the required streamflow regulation.

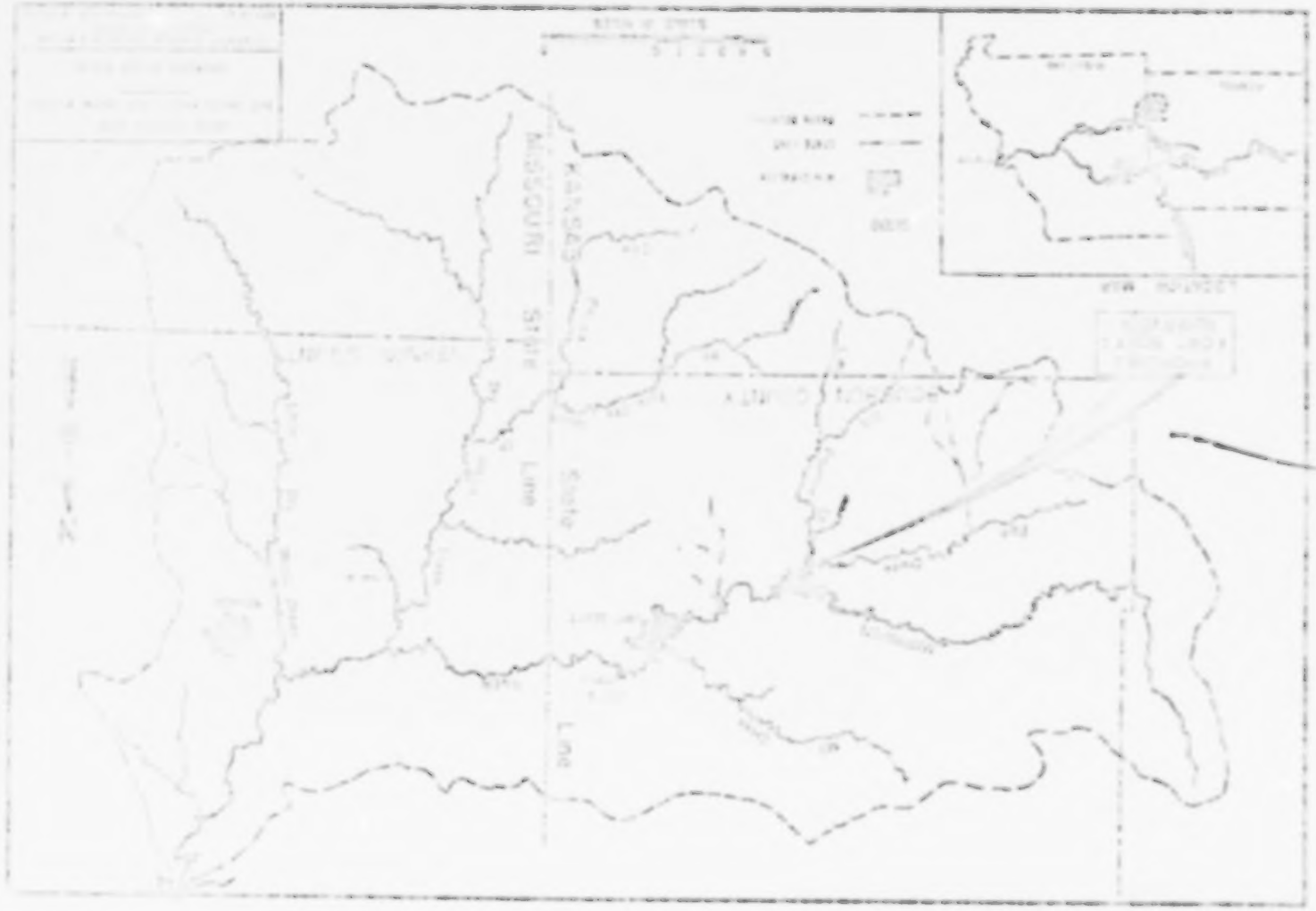
Value of Benefits

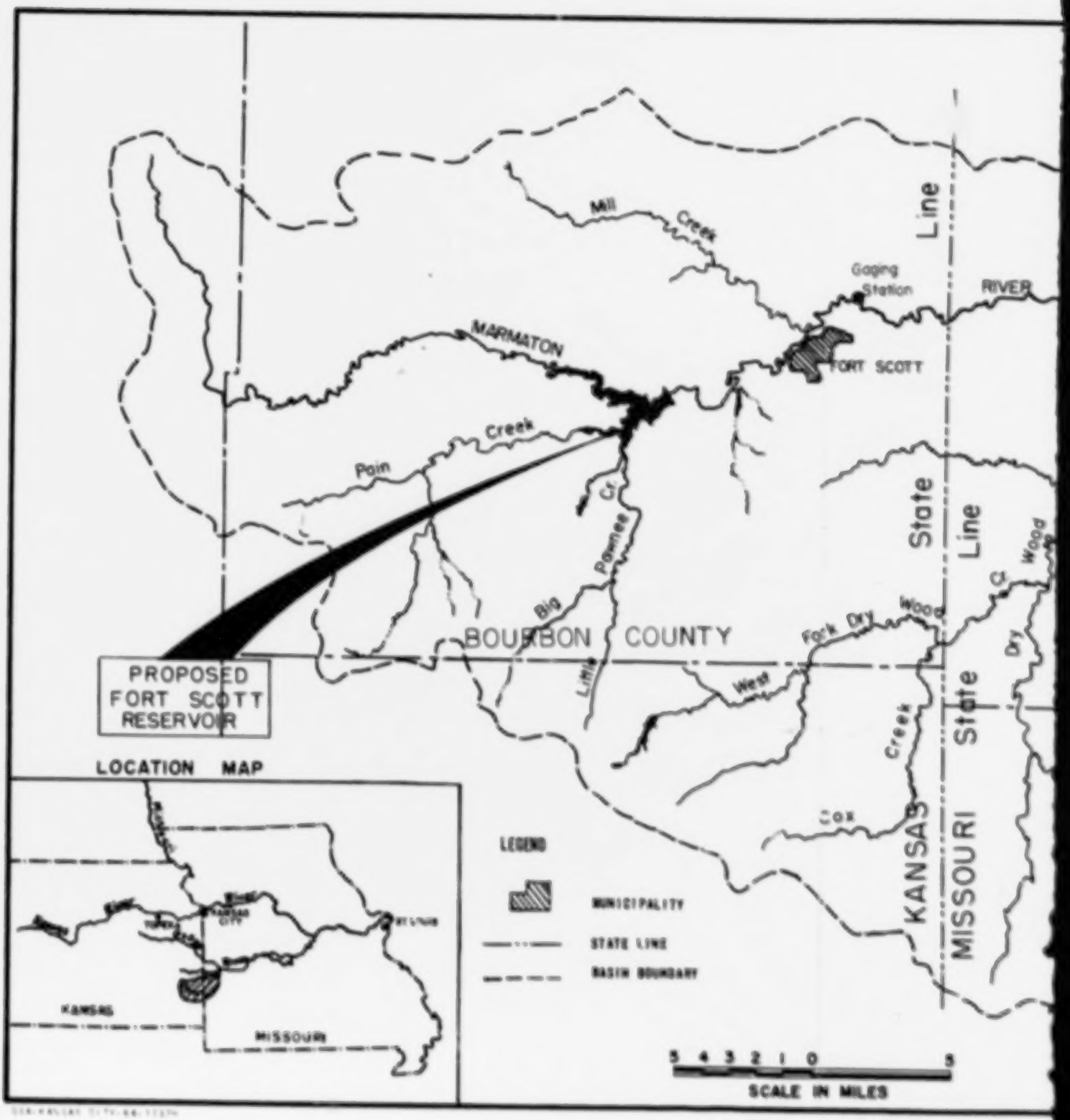
Since no adequate means can be devised to evaluate directly all of the economic effects of water quality control, the cost of achieving the same results by the most likely alternative in the absence of the project has been used as the minimum value of benefits such as those listed above. In this case, the most likely alternative is a single-purpose reservoir at the proposed project site which will provide 17,000 acre-feet of storage (including 5,000 acre-feet for sedimentation) at an estimated cost of $2,400,000. Amortized over 100 years at 3%, the annual cost of this reservoir would be approximately $75,900 or a cost of less than $1.00 per person per year. Since there is an immediate need for streamflow regulation for quality control, this cost has not been discounted and is considered a minimum value of benefits attributable to water quality control storage in the proposed Fort Scott reservoir.

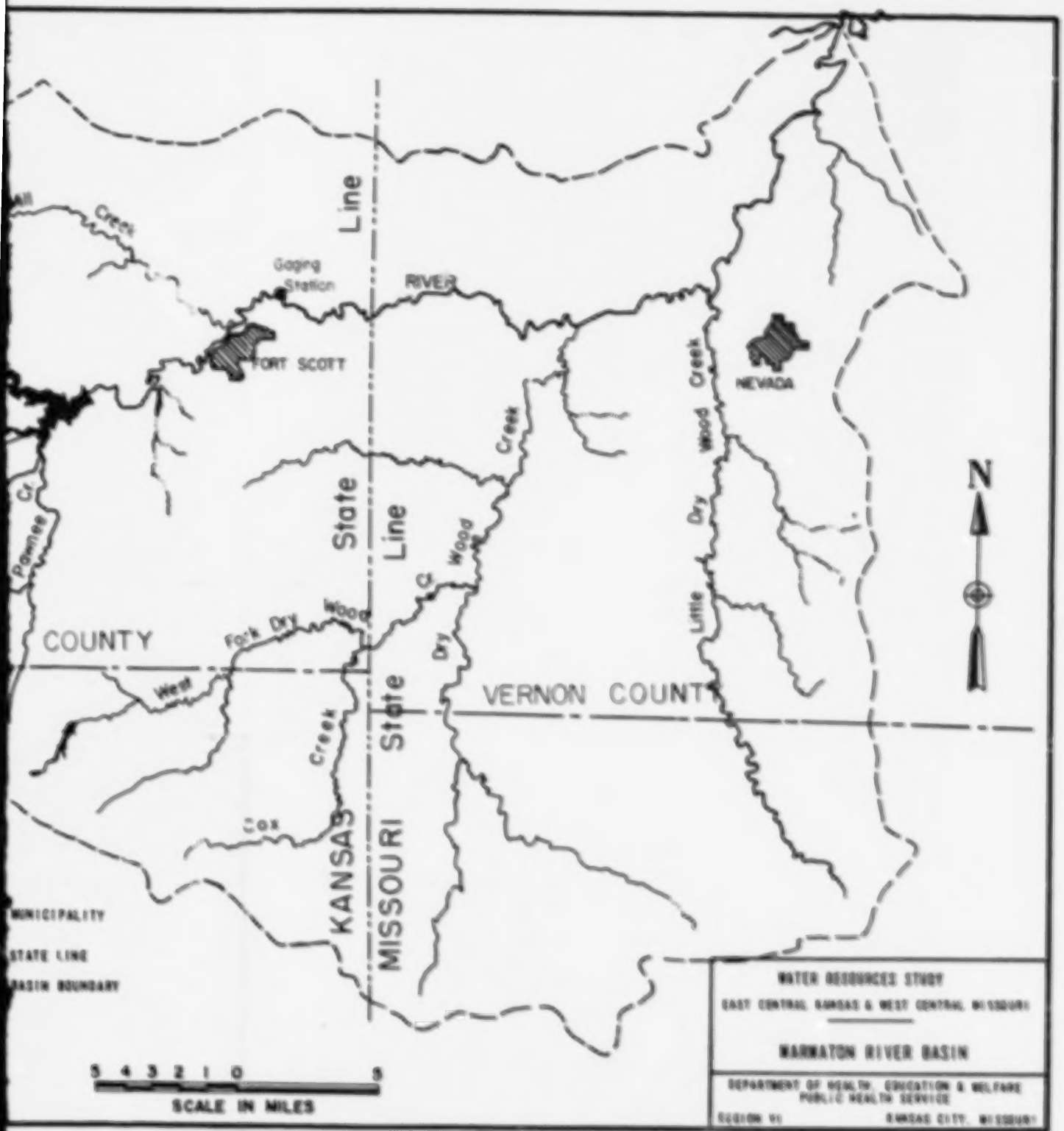
If required storage for streamflow regulation is not provided as recommended, benefits described above will not be realized. Losses will

be suffered due to increased water treatment costs, damage to paint on structures adjacent to, or in, the streams and property values will decline in areas contiguous to the streams. Lacking a water supply of assured quality as well as quantity, industry will be most likely to select other plant sites, all other things being equal, which means economic opportunities will be foregone to the portions of the study area that would otherwise be benefited. Recreation will suffer. Without streamflow regulation it is estimated that the waste loads of Fort Scott, Kansas, will result in a dissolved oxygen concentration in the Marmaton River below Fort Scott of 0.0 mg/l at the 90% protection level in August. When the dissolved oxygen reaches zero, no fish will be found in the river. The river will become the source of noxious odors and paint blackening fumes, and will be worthless for recreational purposes.

IX. MAP OF AREA




Mill Creek
Gaging Station
RIVER
Line
MARMATON
FORT SCOTT
Creek
Pain
Big Pawnee Cr.
State
Line
Wood Cr.
BOURBON COUNTY
Fork Dry
Wood
Little
West
Creek
Dry
Cox
KANSAS
MISSOURI
State
PROPOSED FORT SCOTT RESERVOIR
LOCATION MAP
KANSAS
MISSOURI
LEGEND
MUNICIPALITY
STATE LINE
BASIN BOUNDARY
5 4 3 2 1 0 5
SCALE IN MILES


Line
Gaging Station
RIVER
FORT SCOTT
NEVADA
Creek
Wood Creek
Dry
Little
State Line
Wood Cr
Fork Dry
COUNTY
VERNON COUNTY
Creek
Cox
KANSAS
MISSOURI
N
MUNICIPALITY
STATE LINE
BASIN BOUNDARY
5 4 3 2 1 0 5
SCALE IN MILES
WATER RESOURCES STUDY
EAST CENTRAL KANSAS & WEST CENTRAL MISSOURI
MARMATON RIVER BASIN
DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VI
KANSAS CITY, MISSOURI

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XI. APPENDIX

Exhibit No. 1

Marmaton River Basin

Municipal Water Supplies

Municipality	1960 Population	1963 Population Served	Water Treatment	Source of Supply	Rated Plant Capacity MGD	Average Output MGD	GPCD
(Kansas)							
Arcadia	507	480	Aeration, chlorination	Wells (2)	0.400	0.30	63
Arma	1,296	1,500	Aeration, softening chlorination	Wells (2)		0.071	47
Bronson	354	400	Chlorination	Impoundment	0.04	0.03	75
Fort Scott	9,410	10,500	Coagulation, softening, taste & odor control, fluoridation, chlorination	Marmaton River, Lake Fort Scott, Rock Creek Lake	3.45	1.30	124
Fulton	207	200	Chlorination	Wells (2)	0.03	0.01	50
Moran	549	600	Aeration, coagulation, taste & odor control, chlorination	Impoundment	0.288	0.050	83
Mulberry	642	750	Aeration, chlorination	Well (1)	0.28	0.05	67
Uniontown	211	200	Coagulation, chlorination	Marmaton River, Impoundment	0.043	0.010	50
(Missouri)							
Liberal	612	536	Aeration, chlorination	Well (1)	0.360	0.060	112
Nevada	8,416	8,500	Chlorination	Wells (2)	3.024	0.700	82
Schell City	343	328	None	Well (1)	0.144	0.010	30
	22,547	23,994				2.591	108

Exhibit No. 2

Marmaton River Basin

Typical Chemical Analyses
(Results in Milligrams per Liter)

Location	Type*	Total Dissolved Solids	Chlorides (Cl^-)	Sulfates ($SO_4^{=}$)	Nitrates (NO_3)	Hardness ($CaCO_3$)	Iron (Fe)	Remarks
KANSAS								
Allen County								
Moran	M-T	231	64	10	3.1	188	0.02	Surface Source
Bourbon County								
Bronson	M-T	134	10	15	1.0	110	0.30	Surface Source
Fort Scott	M-T	143	13	53	2.2	100	0.02	Surface Source
Fulton	-R	---	27	65	5.0	352	0.23	Test Well
Marmaton River	-R	210	12	30	2.3	171	---	At Fort Scott
Uniontown	M-T	289	20	62	0.4	244	0.02	Tap-Surface Source
Crawford County								
Arcadia	M-R	790	250	37	0.4	242	0.45	Frisco Well No. 2
Arma	M-R	799	223	55	0.4	285	0.12	Well
	M-T	651	232	71	0.4	108	0.01	Tap
Mulberry	M-R	565	150	36	2.0	226	0.01	Well
MISSOURI								
Vernon County								
Nevada	M-R	1529	610	62	0.1	364	0.08	Well #3

Exhibit No. 2 (cont'd)

Marmaton River Basin

Typical Chemical Analyses
(Results in Milligrams per Liter)

Location	Type*	Total Dissolved Solids	Chlorides (Cl^-)	Sulfates ($SO_4^=$)	Nitrates (NO_3)	Hardness ($CaCO_3$)	Iron (Fe)	Remarks
MISSOURI (cont'd)								
Vernon County (cont'd)								
Schell City	M-T	836	308	30	---	242	0.6	Well
Barton County								
Liberal	M-R	490	112	22	0.0	190	0.14	Well

*M - Municipal Supply
T - Treated
R - Raw

Exhibit No. 3

Marmaton River Basin

Basic Data on Sources of Pollution

Municipality or Industry	River Miles Above Mouth	1960 Pop.	1963 Sewered Pop.	P.E. (BOD) Before Treatment	Nature of Waste	Treatment Provided	P.E. (BOD) Discharged	Water Course
KANSAS								
Fort Scott	273.5-18.2-32.2	9,410	9,300E	13,300E	Domestic & Industrial	Tertiary	1,330E	Marmaton River
Moran	273.5-18.2-65	549	400E	400E	Domestic	Secondary	80E	Dry tributary of Marmaton R.
MISSOURI								
Liberal	273.5-18.2-18-23	612	210E	150E	Domestic	Lagoon	No discharge	Dry Wood Creek
Nevada		8,416						
North Plant	273.5-15-3.2	---	4,800E	4,800E	Domestic	Secondary	700E	Branch of Marmaton River
South Plant	273.5-15-3.3	---	3,000E	3,000E	Domestic	Secondary	400E	Branch of Marmaton River
Nevada State Hospital	273.5-15-3.2	---	---	2,700E	Domestic & Industrial	Lagoon	400E	Branch of Marmaton River
				24,350			2,910	

*Where P.E. exceeds sewered population, the difference is due to industrial wastes.

Exhibit No. 4

Marmaton River Basin

A Sample Distribution of Mean Reservoir Releases Needed for Quality Control in Acre-Feet*

Month	Year		
	1960	2010	2060
January, February, March, April, May, June	0	500	6,270
July, August, September, October, November, December	3,480	7,410	15,500

* Volumes contain 20 percent overage to cover such items as conveyance losses and atypical flow or quality conditions. This is not an operating scheme.